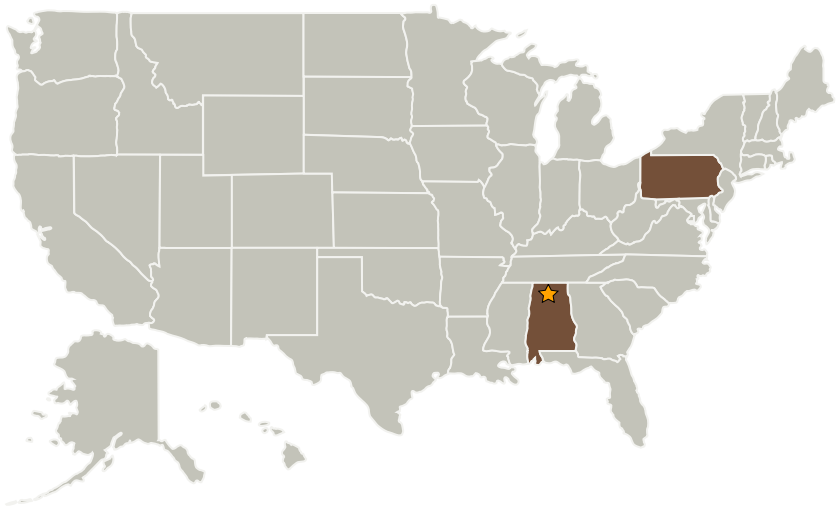
Advanced Numerical Tools for Design and Analysis of In-Space, Valve and Feed Systems, Phase II

Completed Technology Project (2007 - 2009)

Project Introduction

In-space valves are required to provide precise mass flow control, wide throttling range and handle rapid on-off control. These requirements can result in significant unsteady, transient effects both on the fluid mass flow rate, as well as the torque required. However, there currently are no analytical or numerical modeling tools that can predict the unsteady/transient performance of these valves; current design tools are limited to quasi-steady models and empirical correlations. The innovation proposed here is a high-fidelity, comprehensive numerical tool that can characterize the transient performance of these flight valves and provide design support. An innovative approach to modeling valve motion in a broad range of valves designs including showerhead, ball and butterfly valves is proposed; this will permit simulations of transient valve operations and the resulting mass flow history and pressure drop. Unsteady effects at partial valve openings due to both turbulence interactions as well as multi-phase cavitation are addressed with an advanced numerical framework that incorporates both advanced LES models and real-fluid cryogenic effects. The tools and technology developed here would directly impact design support efforts for the J-2X upper-stage engine in the Ares launcher envisioned under the Constellation program for the mission to the moon.

Primary U.S. Work Locations and Key Partners



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Organizations Performing Work	Role	Type	Location
★Marshall Space Flight Center(MSFC)	Lead Organization	NASA Center	Huntsville, Alabama
CRAFT Tech - Combustion Research and Flow Technology	Supporting Organization	Industry	Pipersville, Pennsylvania

Primary U.S. Work Locations	
Alabama	Pennsylvania

Project Transitions

November 2007: Project Start

November 2009: Closed out

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Marshall Space Flight Center (MSFC)

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

Carlos Torrez

Technology Areas

Primary:

- TX01 Propulsion Systems
  - TX01.1 Chemical Space Propulsion
    - TX01.1.1 Integrated Systems and Ancillary Technologies